

The Depredations of the Large White Butterfly (*Pieris brassicae*) (Pieridae)

John Feltwell

35 Fishers Road, Staplehurst, Kent, TN12 ODD, England

Abstract.—An assessment is given of the damage caused by the Large White Butterfly. It is based on reports from the literature, from correspondence with entomologists in various countries, and from analysis of statistics of both the Ministry of Agriculture, Fisheries and Food (MAFF) and the Food and Agriculture Organization (FAO) of the United Nations. Eighteen economic crops are reported as food-plants of the Large White. Almost £1m (\$1.85m)* of *brassica* crops would be lost annually in the United Kingdom with a 1% crop loss. In the Old World a loss of £110m (\$204m) would be expected annually with a 4% crop loss, and in the New World £10m (\$18.5m) could be the expected loss now that the Large White is established in Chile.

It seems appropriate that at a time when man is concerned with critically analysing his returns from crops, he should take a closer look at those insect species which cause small percentage losses over large crop areas. The aim of this paper is to assess the potential threat to Man's crops of the Large White.

Distribution of the pest: The Large White is found in 41 countries, principally in the Old World. Its distribution extends from the United Kingdom (UK) in the west to China in the east and northwards from the African coast to the Arctic Sea (Commonwealth Institute of Entomology 1976). In the last six years it has established itself successfully in Chile (Gonzalez 1972; Gardiner 1974), and now presents a problem in that country.

Devastations pre-1950: Descriptions of attacks on crops by the Large White were plentiful before the 1939-1945 war, when this insect was a more serious pest. Indeed, reports of migrations of "whites" as thick as snowstorms have been reported at intervals from 1556 (Nichols) to 1945 (Ford), including accounts of masses of wandering larvae (Guerne 1894) holding up public transport. From the reports in Europe before 1950 there are many cases of 100% loss of crop; in England, turnips (Cansdale 1876; Granville-Clutterbuck 1941), brussels sprouts (Theobald 1909), kale (Anderson 1909), cauliflower (Zanon 1919), kohlrabi (Friederichs 1931). In Switzerland it was

* Based on £1 = \$1.85 at 18th Dec. 1977

TABLE I
Crops Recorded Eaten by P. brassicae
With An Indication of the Degree of Devastation

Common	Specific Name	Degree of Attack
Cruciferae		
Cabbage	<i>Brassica oleracea</i> var. <i>capitata</i>	1
Savoy	<i>Brassica oleracea</i> var. <i>capitata</i>	2
White	<i>Brassica oleracea</i> var. <i>capitata</i>	2
Blue	<i>Brassica oleracea</i> var. <i>capitata</i>	2
Red	<i>Brassica oleracea</i> var. <i>capitata</i>	2
Chinese cabbage	<i>Brassica oleracea</i> var. <i>capitata</i>	2
Broccoli	<i>Brassica oleracea</i> var. <i>capitata</i>	2
Rape swede	<i>Brassica oleracea</i> var. <i>gemmifera</i>	1
Brussels sprouts	<i>Brassica oleracea</i> var. <i>oleracea</i>	1
Cauliflower	<i>Brassica oleracea</i> var. <i>botrytis</i>	1
Kohl-rabi	<i>Brassica oleracea</i> var. <i>caulorapa</i>	1
Kale	<i>Brassica oleracea</i> var. <i>acephala</i>	2
Black Mustard	<i>Brassica nigra</i> (L.) Koch	2
Turnip	<i>Brassica rapa</i> L.	1
Radish	<i>Raphanus sativus</i> L.	2
Horse Radish	<i>Armoracia rusticana</i> Gaertn, Mey & Scherb.	2
Cress	<i>Lepidium</i> sp.	2
Watercress	<i>Rorippa nasturtium-aquaticum</i> (L.) Hayek	2

(Nonenclature after Clapham, Tutin and Warburg, 1962)

¹ Recorded in the literature as 'entirely eaten', 'defoliated', . . .

² Recorded as 'a foodplant' or as 'eaten'.

reported that both cruciferous and umbelliferous crops were destroyed by larvae at a density of 938 m² (Pictet 1918).

Devastations since 1950: The Large White is a serious pest in Central Europe and Central Asia; in the Netherlands it is regarded as an occasional pest which causes considerable damage, usually only in warm dry years (e.g. 1970) (van Driest, personal communication). In Sweden the Large White is a pest on all kinds of cabbage in the central and southern part of the country (Douwes, personal communication), and in Austria it is regarded as a serious pest on cabbage in five regions (near Linz, in Niedersterreich, Eisnastadt, Burgenland and near Graz) (Berger, personal communication), where it has been strictly controlled (Glaeser, 1974).

In Czechoslovakia all *brassica* vegetables are attacked by *P. brassicae* (Spitzer, personal communication) and in Rumania there have been serious attacks of cabbage crops in 1948-49, 1955-56, 1962-63 and 1970-71 (Mustata and Andriescu, 1973). In Poland, the second generation can also cause considerable damage to cabbage (Przybylski, 1968; Starega, personal communication).

In India, rape and mustard seed have received attacks (Srivastava, 1970) and in Nepal the subspecies *Pieris brassicae nepalensis* has been responsible for considerable damage to cabbage (Chuang-Lung, 1976). *P. brassicae* can also cause serious damage to cabbage crops in Lebanon, Syria and Iraq (Talhouk, 1969); Turkey (Asena, 1974); and Russia (Jakimaricius, 1974).

In the UK, Belgium, France and China, the Large White is now regarded as an occasional minor pest (Depiveux, Milaire and Chaung-Lung, personal communications respectively).

Crops attacked: The larva of the Large White is oligophagous and is known from a wide variety of foodplants. It has been recorded from 114 foodplants in the wild, representing the families Cruciferae, Resedaceae, Papilionaceae, Umbelliferae, Tropaeolaceae (Feltwell, unpublished) and these include species and cultivars of economic crops.

The high risk-crops which are most susceptible to depredations of the Large White in Europe, are cabbages, cauliflowers, Brussels sprouts, rape, kohlrabi, turnip and swede (Table 1). In the Middle East, capers are liable to attack.

Effect on the crop: It is often found that more damage occurs at the periphery of the crop than at the centre (Friederichs, 1931). Where complete defoliation occurs there is obviously no crop to market. Even

slight damage can make the plant unsightly to the consumer and in particular larval frass spoils the market value of a crop.

Brassica production in the UK: The UK was expected to produce about 1m tonnes of cabbage, Brussels sprouts, cauliflower, turnips and swedes during 1976-77, with a market value of £99m (\$183m) (Table II). During the same period, imports of cabbage, cauliflower and broccoli will amount to about £4m (\$7.4m).

Ironically, in the UK no figures are available of the amount of brassicas grown in allotments, where often, because *P. brassicae* is uncontrolled, damage is severe. The number of allotments in the UK is rapidly decreasing. In 1945 there were 1.5m (Handiman Which, 1975), in September 1955 there were 1,004,656 (Best & Ward, 1956), in September 1973 'The Times' quoted 467,755 and in 1975 Handiman Which (*loc. cit.*) quoted about 333,000. Inspection of allotments today shows that brassicas are still grown on at least 5-10% of the total allotment area.

Information on the production of brassicas from gardens is also scant. Best & Ward (*loc. cit.*) stated that 374 kof cabbage, cauliflower and Brussels sprouts can be produced from a ten rod plot. They quoted £4.17.6d (£4.87½) as the value of the total yield of vegetables from each house with a garden in 1952, which would be equivalent to at least double that value today. According to Herwin (1977 pers. comm.) at least £0.75m (\$1.39m) worth of crop is lost annually to the deprivations of this pest in allotments and gardens.

Brassica production throughout the world range of P. brassicae: Data from the current FAO (1975) Production Yearbook shows that 18m tonnes of cabbage and cauliflower were produced in 1974 in Europe and Asia, and about 2m tonnes were produced in the Americas (Table III). World figures for the production of swedes and turnips in North and South America are not available.

Discussion: It is clear that the major areas of attack on brassica vegetables by the larvae of the Large White and its sub-species, are North and Central Europe, India, Nepal and China. It is likely that vegetables grown in the USSR and other iron curtain countries also currently suffer devastations from the Large White but information from these sources is not forthcoming. Some concern over the spread of the Large White in South America, and thus to the rest of the Americas, is felt with its successful establishment in Chile in 1972. In the UK the Large White is now less of a problem than it was before 1955 when an epizootic virus naturally disseminated the resident

population (Smith, 1956). Added to this, British farmers regularly use DDT and organophosphorus insecticides, such as mevinphos and trichlophon, to kill cabbage caterpillars.

In order to assess on a world-wide scale, the damage caused by the Large White and its sub-species, it is necessary to take into consideration the following factors:

- (i) attacks are often extremely localized and in small areas crop loss can be 100%
- (ii) the strongly migratory habit of the Large White helps to disperse it over wide areas and may help it to infest areas previously free from attack.
- (iii) the larvae can develop on a wide variety of foodplants, including both cultivated and wild crucifers.
- (iv) populations are regulated by a large number of predators, hymenopterous parasites and micro-organisms such as viruses, bacteria, protozoa and fungi.
- (v) warm and dry years usually result in an increase in the population of this insect.

The above factors make an assessment of the overall degree of attack by this pest extremely difficult. Furthermore, there are communication difficulties in obtaining first-hand information about the degree to which *P. brassicae* attacks crops in the various countries within the world range and indeed about each species of crop attacked. However, taking the four brassicas most attacked in the UK as an example (Table II), a 1% loss due to the Large White would result in a loss of approximately £1m (\$1.85m) worth of crop in 1977. In countries such as Austria, Poland and Sweden where damage is more severe, many millions of pounds worth of crop must be lost to *P. brassicae*.

Europe and USSR produced 11m tonnes of cabbage and cauliflower in 1974 (Table III). If a 4% theoretical loss of yield is applied for this region, the tonnage lost would be about 0.35 tonnes or about £35m (\$55m) based on 1977 prices. (Forecast average of the two is nearly £100 (\$185) tonne. In Asia and China, the production of cabbages for 1974 was about half that of Europe and for North and South America about one third. Thus one could tentatively calculate that at least £60m (\$111m) worth of cabbage and cauliflowers are lost annually in Europe and Asia. Bearing in mind that this figure has not been corrected for inflation and also does not include either the other 18

TABLE II

*Production of Value of the Four Principal Foodplants
of *Pieris brassicae* in the United Kingdom*

Crop	Hectares		Value of	
Crop	Hectares	Tonnes	output (£)	(\$)
Cabbage	24,581	468,900	40,810,000	75,498,500
Imported	—	14,800*	1,646,000*	3,045,100
Brussels sprouts	13,351	141,700*	25,506,000	47,186,100
Cauliflower	14,340	193,100	21,394,000	39,578,890
Imported (+broccoli)	—	16,500*	2,018,000*	3,733,300
Imported (+Channel Isles)	—	6,000*	638,000*	1,180,300
Turnips and swede	5,239	124,000	7,428,000	13,741,800
Totals	57,511	975,000	99,440,000	184,014,000

(based on Ministry of Agriculture, Fisheries and Food Statistics 1976/77 Forecast.)

* only figures available 1975/76

TABLE III

*Cabbage and Cauliflower Production in
Europe,, USSR and Asia, 1974*

Country	Tonnes of cabbage	Tonnes of cauliflower
Europe	7,698,000	2,128,000
Asia and China	3,959,000	851,000
N. America	1,504,000	151,000
S. America	180,000	60,000
Europe USSR	3,218,000	298,000
Total	16,550,000	3,428,000

(based on FAO (1975) Production Yearbook for 1974)

species of crop attacked or the crops attacked in non-commercial areas, gardens and allotments, the figure for destruction to all crops could easily be nearer to £100m (\$185m). A potential threat of about £10m (\$18.5m) loss per annum in the Americas is posed by the presence of *P. brassicae*.

It is therefore clear that a considerable amount of potential human food is eaten each year by the larvae of *P. brassicae*; and that the major areas of infestation are Central Europe and Asia. The possibility of returning £110m (\$204m) worth of food material to Man each year, is an incentive to look for an effective way of control of the insect; even a 50% reduction in the world population of *P. brassicae* would return £30-50m (\$56-93m) worth of crops to hungry mouths in both developed and underdeveloped countries.

Acknowledgements. I am very grateful to Miss M. Gratwick (Plant Pathology Laboratory, Harpenden), Dr. M. Anderson (Countryside Planning Unit, Wye), Dr. C. Hodgson and Dr. M. Copland (both of Wye College) for advice and discussion on logistics. Dr. S. Finch (National Vegetable Research Station, Wellesbourne) very kindly checked the manuscript and Mr. E. Hewin (ADAS) made useful comments.

Literature Cited

- ANDERSON, J. 1909. Extraordinary abundance of, and destruction by, the larvae of *Pieris brassicae*. *Entomologist* 42:282
- ASENA, N. 1974. Investigations on vegetable pests in west and south-west Anatolia (in Turkish) *Diyarbakir Bolge Zirai Mucadele Arastirma Enstitusu, Turkey*. 134-135
- BEST, R. H. and WARD, J. T. 1956. *The Garden Controversy*. Department of Agriculture Economics, Wye College.
- CANSDALE, W. D. 1876. Ravages of *Pieris brassicae*. *Entomologist*. 8-9:257
- CHUANG-LUNG, L. 1963. Results of an entomological expedition to Tibet, in 1960-61 (Lepidoptera, Rhopalocera) (in Chinese). *Acta zoologica Sinica* 15:(3) 453-456
- CLAPHAM, A. R., TUTIN, T. G. and WARBURG, E.F. 1962. *Flora of the British Isles*. Cambridge University Press. London.
- COMMONWEALTH INSTITUTE OF ENTOMOLOGY 1976. *Distribution of maps of Insect pests*, Series A, Map No. 25. *Pieris brassicae*.
- FOOD AND AGRICULTURE ORGANIZATION. 1975. *Production Yearbook 1974* 28.1, 28.2.
- FORD, E.B. 1945. *Butterflies*. Collins, London.
- FRIEDERICHS, K. 1931. Zur Okologie des Kohlweisslings (*Pieris brassicae*). *Z. angewandte Ent.*, 18:(3) 568-581.
- GARDINER, B.O.C. 1974. *Pieris brassicae* L. established in Chile; another Palearctic pest crosses the Atlantic (Pieridae). *J. Lep. Soc.*, 28:(3) 269-277.
- GLAESER, G. 1974. Das Auftreten wichtiger Schadurachen an Kulturpflanzen in Oesterreich im Jahre 1973. *Pflanzenschutz Ber.*, 44: (8-10) 113-126.

- GONZALEZ, R. H. 1972. FAO Plant Protection Bulletin. 20:(4) 89-91.
- GRANVILLE-CLUTTERBUCK, C. 1941. Notes on lepidoptera at the Lizard in 1920. *Entomologist* 74: 121-123
- GUERNE, J. 1894. Invasion de chenilles de *Pieris brassicae*. *Annl. Soc. ent. Fr.*, 63:241.
- HANDYMAN WHICH. 1975. *Allotments* p. 29.
- JAKIMARICIUS, A. 1974. On the parasites of vegetable garden pests in Lithuania . (in Lithuanian) *Lieturos Tsr Mokslu Akademijos Zoologijos ir parazitologijos Institutas, Lithuanian SSR* 183-188.
- MINISTRY OF AGRICULTURE, FISHERIES AND FOOD, 1974. *Advisory Leaflet 69: Cabbage Caterpillars*. Amended 1974. London.
- MUSTATA, G., and ANDRIESCU, I. 1973. Recherches sur le complexe de parasites (Insecta) du Papillon du chou (*Pieris brassicae* L.) en Moldavie (R.S. de Roumanie). I Parasites primaires. *Ecol Terestra si Genetica*. 1972-73: 191-230.
- NICHOLS, J. G. 1556. *The Chronicle of Calais in reigns of Henry VII & Henry VIII to the year 1540*. Cambden Society, Nichols, London.
- PICTET, A. 1918. Observations biologiques sur *Pieris brassicae* en 1917. *Bull. Soc. Lepidopt. Geneve*. 4: (1) 53-56.
- PRZYBYLSKI, Z. 1968. Development of the second generation of the cabbage white butterfly *Pieris brassicae* L. (Lep:Pieridae) in agricultural climatic conditions of Rzeszow region (in Polish). *Pol. Pismo. entomol.*, 38: (4) 897-906.
- SRIVASTAVA, A. S. 1970. Important insect pests of stored oil seeds in India. *Intern. Pest Control.*, 12: (3) 18-20.
- TALHOUK, A. M'IMS. 1969. Insects and mites injurious to crops in Middle Eastern countries. *Monographien zur agnew Entomologie No. 21*. Verlag Paul Parey, Hamburg & Berlin. pp. 198-199.
- THEOBALD, F. V. 1909. Animals injurious to vegetables. *J. S. E. Agri. Coll. Wye*. 1909: 157-164.
- ZANON, V. 1919. Horticulture at Benghasi, Tripoli. *Agri. colon Florence* 13:154-176.